

## **The impact of perceived injustice on appraisals of physical activity: An examination of the mediating role of attention bias to pain in a chronic low back pain sample**

Trost, Z, PhD<sup>1\*</sup>, Van Ryckeghem, D<sup>2</sup>, Scott, W<sup>3</sup>., Guck, A<sup>1</sup>, Vervoort, T, PhD<sup>2</sup>

- 1 Department of Psychology - University of Alabama at Birmingham, USA
- 2 Department of Experimental-Clinical and Health Psychology, Ghent University, Belgium
- 3 Department of Psychology, Institute of Psychiatry, Psychology, and Neuroscience King's College London, England

\* Corresponding author: Zina Trost, Department of Psychology, University of Alabama at Birmingham, Birmingham, AL, USA; Tel: (917) 209-4866; Email: [ztrost1@uab.edu](mailto:ztrost1@uab.edu)

**DISCLOSURES:** The authors acknowledge the International Association for the Study of Pain (IASP) Early Career Grants Program for their support of this study. The authors have no disclosures of any additional funding or any relationships that might lead to a conflict of interest.

### **Abstract**

The current study examined the relationship between perceived injustice and attentional bias (AB) toward pain among individuals with chronic low back pain asked to perform and appraise the pain and difficulty of a standardized set of common physical activities. A pictorial dot-probe task assessed AB toward pain stimuli (i.e., pain faces cueing pain), after which participants performed the physical tasks. Participants also rated face stimuli in terms of pain, sadness, and anger expression. As hypothesized, perceived injustice was positively associated with AB toward pain stimuli; additionally, perceived injustice and AB were both positively associated with appraisals of pain and difficulty. Counter to expectations, AB did not mediate the relationship between perceived injustice and task appraisals, suggesting that AB is insufficient to explain this relationship. Exploratory analyses indicated that participants with higher levels of perceived injustice rated stimulus faces as sadder and angrier; no such differences emerged for pain ratings. This is the first study to examine the association between perceived injustice and AB toward pain, as well as perceived injustice and in-vivo appraisals of common physical activity. Results extend existing literature and suggest that attentional and potential interpretive bias should be considered in future research.

**Perspective:** This article identifies significant associations between perceived injustice, biased attention to pain, and appraisals of common physical activities among individuals with chronic low back pain. These findings suggest targets for intervention as well as directions for future research regarding individuals with high perceptions of injustice related to pain.

**Keywords:** *perceived injustice, selective attention, pain, anger, chronic low back pain*

## INTRODUCTION

A growing body of research suggests that perceptions of injustice contribute to detrimental physical and psychological outcomes both among individuals with recent injury [43] and chronic pain conditions [13,26,31,38]. Pain-related injustice perception has been conceptualized as a cognitive appraisal reflecting the severity and irreparability of pain- or injury-related loss, externalized blame, and unfairness [37,38]. Outcomes associated with elevated injustice perception have included greater self-reported pain and disability [32,37], higher pain behavior [39], and poorer outcomes following rehabilitation treatment [38] and surgery [55]. Elevated perceptions of injustice are likewise associated with greater self-reported depressive symptoms [26,30,31,38,39,41] and the persistence of posttraumatic symptoms following injury [41].

A number of mechanisms have been proposed to explain the negative impact of injustice perception. Previous studies have explored and found partial support for the role of emotional distress [37], pain behavior [39], and anger [31]. Recent reviews have suggested that *attentional bias (AB) to pain* might comprise another potential mechanism by which injustice perceptions systematically impact on pain-related outcomes [36,38]. In the context of perceived injustice, the explanatory role of AB is supported by the positive relationship between perceived injustice and other risk factors for problematic pain outcomes, namely pain-related fear and catastrophic thinking [37,38]; both have been associated with AB to pain [1,18,45,50-52,56]. Further, the role of attention in pain outcomes is central within leading cognitive-affective models of pain (e.g., the Fear-Avoidance Model [11,54]) and supported by findings linking biased attention to pain to increased levels of pain severity, chronicity, and disability (e.g., [4,33,48] but see [5]), potentially by promoting avoidance behaviour. For example, a recent study by Van Ryckeghem

and colleagues further supported the role of attention in functional outcomes by showing that elevated levels of AB to pain strengthened the relationship between daily pain severity and distractibility from ongoing daily activity [48]. However, the role of attention in injustice-related outcomes has not yet been empirically examined. Moreover, previous studies have largely focused on the relationship of injustice with global retrospective and prospective reports of pain intensity and disability with respect to various domains of daily living [32,51]. To date, no study has examined the impact of injustice perception on pain and disability appraisal *during actual performance of everyday physical activity*. Identification of mechanisms active in daily life is vital to inform the development of interventions to mitigate the impact of perceived injustice in people with chronic pain. Additionally, investigation of mechanisms linking perceived injustice to pain outcomes stands to improve theoretical understanding regarding the role of perceived injustice in pain as well as inform clinical interventions.

Accordingly, the current study examined the relationship between perceived injustice and AB for pain in a sample of individuals with chronic low back pain asked to perform common everyday activities. Participants' attention toward personally-relevant pain stimuli (i.e., faces cueing different levels of personally relevant pain) was assessed via a pictorial dot-probe methodology (e.g., [50,53]), followed by completion of a standardized sequence of everyday physical activities during which participants provided ratings of perceived pain and difficulty. Extending and replicating previous research, it was hypothesized that perceived injustice would show a positive association with AB to pain-related stimuli and that perceived injustice and AB to pain would be associated with greater self-reported pain and perceived difficulty in response to physical exertion. In addition, we hypothesized that AB toward pain would mediate the relationship between participants' pain-related injustice perceptions and, respectively, ratings of

pain intensity and difficulty during physical task performance. Finally, exploratory analyses examined the association between injustice perception and participants' ratings of pictorial stimuli. Given the previously demonstrated association between perceived injustice, anger [31,44], and depression [26,41], participants were asked to not only rate pain but also anger and sadness of pictorial stimuli.

## **METHODS**

### Participants

Participants were recruited from the community through advertisements in local community settings, newspapers, and online classifieds. Individuals expressing interest in participation were screened by phone to determine study eligibility. Participants were included in the study if they were between the ages of 18 and 70 years old, endorsed the presence of low back pain for at least 6 months, and reported that pain significantly interfered with daily activities (Thus, participants self-identified as having chronic low back pain; this was not corroborated by official physician diagnosis). Individuals were excluded from participation if they reported co-occurring medical conditions that impacted mobility and/or if they were currently pregnant. Participants were compensated \$60.00 for completion of the full study protocol. All aspects of this protocol were reviewed and approved by the University Institutional Review Board (IRB).

### Measures

#### *Perceived injustice*

The Injustice Experiences Questionnaire (IEQ; [38]) was used to assess pain-related perceptions of injustice. Participants rated the frequency with which they experienced each of 12

pain-related thoughts on a 5-point scale, ranging from 0 (never) to 4 (all the time). Previous findings suggest that the IEQ yields two correlated factors, labeled *severity/irreparability of loss* and *blame/unfairness*. Severity/irreparability items include, “Most people don’t understand how severe my condition is”, and “My life will never be the same”. Blame/unfairness items include, “I am suffering because of someone else’s negligence”, and “It all seems so unfair”. The IEQ has been shown to have strong reliability and validity among individuals with persistent musculoskeletal pain [32,38]. Cronbach’s alpha for IEQ in the current study was .92, indicating good internal consistency.

#### Stimulus material for the attentional bias task

The stimulus set consisted of 32 pictures of 8 adult faces (4 male and 4 female). All 32 pictures have previously been used by Vervoort and colleagues (see [50,53]). These pictures are taken from one-second video clips of simulated facial expressions of pain taken from a larger collection of such stimuli previously created and validated in the laboratory by Simon et al. [35]. The stimulus set compiled by Simon et al. [35] consists of various emotional expressions simulated by 8 actors, including simulation of various levels of pain. For previous [50,52,53] and current study, all the pain stimuli from the Simon et al. [35] dataset were used. Specifically, eight actors were videotaped while producing facial displays of pain at four different levels – neutral facial expression (NFE), low facial expression (LFE), moderate facial expression (MFE), and high facial expression (HFE). These video clips have been reliably coded for occurrence and intensity of facial pain expression by means of the Facial Action Coding System [12]. Using the 32 selected pictures, a series of three different pairs were generated, resulting in 24 study slides. Each slide consisted of two pictures of the same adult presenting a simulated neutral facial expression combined with either (1) a low facial expression of pain; (2) a moderate facial

expression of pain; or (3) a high facial expression of pain. The selection of different pain expression levels allowed us to examine whether AB in relation to perceived injustice is moderated by varying levels of pain expressiveness. Additionally, 8 images of two additional persons showing no pain expression were selected for practice trials. The above stimulus set and procedures have been used in prior research examining AB to pain (see e.g., [50,52,53]). The validity of the present stimulus set is supported by previous findings that differential facial pain expressiveness (i.e., NFE, MFE, LFE, HFE) reflects differences in observers' pain intensity ratings such that increasing levels of facial pain expressiveness correspond with observers' increasing pain ratings. Specifically, Vervoort et al. (see also [53]) reported that observers' pain intensity ratings, on a 0-10 Numerical Rating Scale, of high expressive pain faces ( $M = 7.59$ ,  $SD = 1.30$ ) were significantly higher than ratings of moderate expressive pain faces ( $M = 5.83$ ,  $SD = 1.69$ ). Moderate expressive pain faces were rated significantly higher in pain intensity than low expressive pain faces ( $M = 3.98$ ,  $SD = 1.70$ ) and low expressive pain faces were rated significantly higher in pain intensity than neutral faces ( $M = .75$ ,  $SD = .76$ ). These intensity ratings are comparable to those observed in the present study (see Results; Table 2). The stimulus set is available upon request.

#### Dot-probe task

Participants were seated in front of a computer at a distance of approximately 60 cm from the screen. Instructions for the dot-probe task were presented on the computer screen. To ensure that the participant understood task instructions, the experimenter briefly checked with the participant prior to task commencement. Additionally, to enhance personal salience of pain cues (i.e., observed facial pain expression), participants were informed that they would be looking at images of individuals who performed the same activities as they themselves would perform

following the dot-probe task. Participants were instructed that there would first be a practice phase of the dot-probe task, after which they could gain clarification on the task before proceeding to the test phase of the task.

All pictorial stimuli were presented against a black background. Each trial in the dot-probe task began with a 500 ms (millisecond) presentation of a white fixation cross in the middle of the screen. Participants were instructed to fixate their gaze on this location. Then, one picture-pair (NFE-LFE; NFE-MFE; NFE-HFE) appeared and remained visible for 500 ms; each facial image in this pair was 47 mm in width and 78 mm in height; one of the pictures was presented above and one below the fixation cross with the center of the picture having a distance of 57 mm above and below (respectively) the center of the screen. Immediately after the offset of these two pictures, a small white rectangle (i.e., the probe; 0.9/1 cm) was presented at the location of one of the pictures. Participants had to indicate the probe location by pressing one of two buttons as quickly and accurately as possible on a QWERTY keyboard. The 'q' key was pressed with the left index finger when the probe was presented at the upper location and the 'p' key was pressed with the right index finger when the probe was presented at the lower location. A new trial started after a response or automatically when 2500 ms elapsed without response. When a participant responded erroneously, the term 'error' briefly appeared on the screen (200 ms). To discourage participants from attending to only one side of the display and responding to the mere presence or absence of the dot-probe, a number of trials were presented in which the target was not followed by a probe ("catch trials"). Furthermore, to ensure that participants maintained gaze at the middle of the screen, a number of digit trials were presented. During these trials, the fixation cross was followed by a randomly selected digit between one and nine for a duration of 150 ms ("digit trials"). Participants were instructed to type the number on the keyboard (see e.g.,



[48,53]). Pictures were presented in randomized order across trials and participants. For the test trials, the target pictures as well as the probe were presented equally often at the top or bottom position of the screen and the dot-probe was equally likely to replace either a pain face or neutral face.

In the context of the current study, *congruent* trials were those where the probe was presented at the same location as a face showing a pain expression. *Incongruent* trials were those where the probe was presented at the same location as a neutral face. Each trial type was presented 32 times for each level of facial pain display (LFE, MFE, HFE) and the inter-trial interval was set to 200 ms. The task began with 20 practice trials consisting of neutral face-pairs, none of which appeared in the experimental trials. Practice trials were repeated until the participant demonstrated ability to perform accurately. The experiment itself consisted of 192 test trials, 24 catch trials and 10 digit trials. The dot-probe task was programmed and presented using the INQUISIT Millisecond software package (INQUISIT 2.0) on a Dell computer with a 15-inch color monitor. INQUISIT measures reaction times (RTs) with millisecond accuracy [7].

#### Standardized physical activities and appraisals of pain intensity and perceived difficulty

Participants were asked to perform a series of three standardized activities: (1) lying down on and standing up from a bed, (2) sitting down on and standing up from a chair, and (3) lifting a crate from the ground, placing it on a table, and replacing it on the ground. Each activity was performed twice in succession. The order of movement performance did not vary across participants. The selection of these movements is modeled after De Ruddere and colleagues [8-10] and based upon previous findings indicating that these routine daily tasks require movement that is usually sufficient to increase pain and to elicit pain behaviour [25]. The experimenter provided instruction (without modeling) regarding performance of each movement (e.g. “When I

say go, please lift the crate from the ground and place it on the table. You can pause briefly and then put it back on the ground when you feel ready”). Participants were allowed to perform activities at self-selected speed and at self-selected intervals, taking breaks as needed. Following performance of each trial of a given activity, participants rated their *experienced level of pain* during activity performance as well as their *perceived difficulty* of performing the activity using a 0-10 NRS with the end points ‘no pain/worst possible pain’ and ‘not at all difficult/extremely difficult’. The 6 pain intensity ratings and 6 difficulty ratings were subsequently averaged across activities, resulting in a single mean pain intensity rating and a mean perceived difficulty rating, respectively. Each rating ranged from 0-10. This approach was justified as (1) corresponding variables for the three activities were all significantly and highly intercorrelated (range .64 - .95), and (2) analyses of the effects of perceived injustice and AB upon pain and difficulty ratings indicated similar results for all activities.

### Appraisal of Pictorial Stimuli

#### *Pain intensity*

At the conclusion of the experiment, participants were asked to rate each picture shown during the dot-probe task with respect to pain intensity using a 0-10 Numerical Rating Scale (NRS) with the end points ‘no pain at all’ and ‘a lot of pain’. Pictures were presented on a computer screen using PowerPoint in identical order across participants. Participants were instructed to make written ratings of perceived pain intensity and were encouraged to proceed as fast as possible. Picture ratings were averaged for each level of facial pain display (across all images; NFE, LFE, MFE, HFE) resulting in 4 mean pain intensity ratings ranging from 0-10. Assessment of participants’ pictorial pain intensity ratings allowed us to check whether

differences in facial pain expressiveness of the pictures matched differences in participants' pain intensity ratings and to explore such ratings' relationship to perceived injustice.

### *Anger and sadness*

Participants were also asked to rate the anger and sadness of each face presented during the dot probe task. As noted, inclusion of these variables allowed exploratory analyses regarding the relationship of perceived injustice with perceived anger and sadness ratings in the context of an attentional task, particularly given the personal relevance of the stimuli (i.e., participants expected to undergo the same task as individuals in the pictures). Collection of anger and sadness ratings followed the same procedure as pain intensity ratings, described above. Similar to pain intensity ratings, ratings for anger and sadness, respectively, were averaged for each level of facial pain display (NFE, LFE, MFE, HFE) resulting in 4 mean anger ratings and 4 mean sadness ratings ranging from 0-10. To control for any potential order effect, order of administration of pain, anger and sadness ratings was randomized across participants.

### Procedure

Upon arrival to the lab, participants completed informed consent and measures assessing demographic information (i.e., age, gender, pain duration) as well as a measure of perceived injustice (IEQ) related to back pain. Participants were then provided instructions regarding the dot-probe task and, following successful familiarization with the protocol, left alone in the testing room to complete the dot-probe task. Next, participants were asked to perform the sequence of standardized physical activities and to provide ratings of experienced pain and perceived difficulty. Following physical task performance, participants were asked to provide ratings (pain, anger, sadness) of the 32 pictures previously observed during the dot-probe task.

### Data reduction and statistical plan

Means (standard deviations) and frequencies were computed for demographic variables. Bivariate Pearson correlational analyses examined associations between study variables, including the association between perceived injustice and participants' self-reported pain intensity and perceived difficulty accompanying physical task performance.

To investigate the impact of *perceived injustice upon selective attention to pain*, the mean reaction times (RT) on congruent and incongruent trials for each level of facial pain display (HFE, MFE, LFE) were calculated and used as dependent variables in a  $3 \times 2$  factorial repeated measures design with facial pain expression (HFE, MFE, LFE) and trial congruency (congruent/incongruent) as within subject factors, and perceived injustice entered as covariate. A main effect of congruency is indicative of *selective attention* to pain faces, that is, when responding is faster to probes on congruent trials (when the probe is presented at the same spatial location as the pain face) than to probes on incongruent trials (when the probe is presented at a different spatial location than the pain face). A main effect of the intensity of facial pain expressiveness is indicative of *task interference*, reflected by slowing down of responses on both congruent and incongruent trials as threat value increases (i.e., increasing facial pain expressiveness). An interaction effect between congruency and facial pain expressiveness indicates that selective attention to pain faces depends upon the level of facial pain expressiveness and allows further examination of whether AB in relation to perceived injustice is moderated by varying levels of pain expressiveness. Examination of moderation effects of facial pain expressiveness is in line with previous research [see e.g., 50,52] and followed procedures outlined by Holmbeck et al. [17]. Specifically, additional repeated measures ANOVAs were performed for low (- 1SD below the mean), and high (+1SD above the mean) values of the centred moderator variable (i.e., participants' level of perceived injustice) when higher order interactions including congruency

*and/or* facial pain expression were significant. Whenever the sphericity assumption was violated (Mauchly's test of sphericity was  $p < .05$ ), Greenhouse-Geisser corrections (with adjusted degrees of freedom, or NDf) were performed. Since a significant association of AB with perceived injustice as well as the outcome measures is a necessary prerequisite for mediation analysis (see [17]), additional correlational analyses were run to examine the association between resulting AB indices and outcome measures (i.e., ratings of pain and perceived difficulty following physical task performance).

Given that conditions for mediation were met (see below), we used a bootstrapping method to investigate whether the association between perceived injustice and ratings of pain and difficulty was mediated by AB to pain. In particular, we used a bootstrapping method (i.e., a non-parametric resampling procedure with 5000 bootstrap resamples and 95% bias-corrected bootstrapped confidence intervals) following the procedure described by Preacher & Hayes [23]. Mediation is assessed with this method by comparing the total effect (weight  $c$ ) of an independent variable (IV) on a dependent variable (DV), which is composed of a direct effect (weight  $c'$ ) of the IV on the DV and an indirect effect (weight  $ab$ ) of the IV on the DV through a proposed mediator. Specifically, to test for mediation a distinction has to be made between various effects and their corresponding weights. The total effect of perceived injustice on pain/difficulty (weight  $c$ ) consists of (1) a direct effect of perceived injustice on pain/difficulty (weight  $c'$ ) and (2) an indirect effect of perceived injustice on pain/difficulty through a proposed mediator, i.e., AB to pain (weight  $ab$ ). The effect of perceived injustice on AB is represented by weight  $a$ , whereas weight  $b$  is the effect of AB on pain/difficulty, partialling out the effect of perceived injustice [15,23]. If there is a significant amount of variance between the IV and DV explained by the proposed mediator, the indirect effect is significant. Bootstrapping produces

sampling distributions of the indirect effect and produces point estimates that are considered significant if the 95% bias-corrected bootstrapped confidence intervals do not include zero.

## RESULTS

### Data preparation

Five participants were discarded from analyses due to sub-optimal dot-probe task performance (i.e., less than 80% of the trials correct; e.g., [49]). Additionally, two participants were missing IEQ responses. Analyses are based upon the remaining final sample of 53 participants. Participants who were discarded did not differ from those who entered the analyses in terms of age or any of the other measures (all  $t \leq 1.26$ , ns), except for experienced pain and perceived difficulty which were both higher among those excluded (both  $t \geq 3.9$ ,  $p < .0001$ ). For the AB analyses, trials with errors were discarded from the final sample for further analyses. Mean percentage of dot-probe errors made by participants was 2.67%. In addition, RTs shorter than 200ms or longer than 2000ms were discarded, as these can be considered outliers. Probe detection latencies that were three standard deviations above or below the individual mean latency time were also excluded from statistical analyses [20,50]. Errors and outliers were evenly distributed across different trial types. The mean percentage of outliers per participant was 4.17%. Statistical analyses were run on 94.5% of the data.

### Participant characteristics

Means, standard deviations and Pearson correlations between study measures are shown in Table 1. Participants included 28 males and 25 females. Participant ranged in age from 19 – 70 years ( $M=39.13$ ;  $SD=13.16$ ). Duration of pain ranged from 1 to 30 years ( $M=9.18$ ;  $SD=6.9$ ). Of the participants, 38 identified as White, 9 identified as African American, 3 identified as

Hispanic, and 3 indicated multiple ethnic backgrounds. Participants' reported levels of perceived injustice ( $M=21.91$ ;  $SD=13.08$ ) were comparable to mean levels obtained in other chronic pain samples (see, e.g., [32,38]). Male and female participants did not differ significantly on any study variables listed in Table 1.

Forty-nine participants were able to describe the etiology of their pain complaint. Of these, the majority reported pain originating from a car accident ( $N=13$ ) or lifting/moving heavy objects ( $N=13$ ); 8 reported sustaining injury outside these categories (e.g., sports, falling); 4 reported that pain began with excessive use of their back; 2 reported that pain was secondary to another condition (e.g., scoliosis); 9 individuals indicated that their pain had no specific trigger. 40 participants reported seeing at least one treatment provider for management of their pain condition. Fifteen participants reported seeing 2-3 pain care providers. Twenty-seven participants reported regularly taking pain medication. Further, of the entire sample, 4 participants were currently involved in litigation for their condition and 5 were receiving government compensation related to their condition.

### Correlational analyses

Of particular importance to the current study (as prerequisite for mediation analysis), bivariate correlations indicated that *perceived injustice was significantly positively associated with reports of experienced pain and perceived difficulty* following physical task performance, with participants reporting higher perceived injustice reporting greater pain experience and perceived difficulty ( $r=.41$ ;  $p<.01$  for both ratings). Participant age and pain duration were both significantly positively associated with level of perceived injustice, with older individuals and those with longer pain duration reporting significantly higher perceived injustice ( $r=.32$  and

$r=.27$ , both  $p<.05$ , respectively). Finally, participants' pain and perceived difficulty ratings following task performance were highly positively interrelated ( $r=.98$ ;  $p<.01$ ).

#### Attentional bias to pain: The explanatory value of perceived injustice

Mean RTs for different trial types are presented in Table 3. RTs were analyzed using a 3 (facial pain intensity: NFE-LFE pairs / NFE-MFE pairs / NFE-HFE pairs)  $\times$  2 (congruency: congruent / incongruent) repeated measures analysis of covariance (ANCOVA) with perceived injustice entered as covariate. A main effect of congruency was found ( $F(1,51) = 4.13$ ,  $\epsilon = .88$ ;  $\text{Ndf}(.77, 44.88)$   $p <.05$ ) indicating that participants preferentially allocated attention towards faces expressing pain; i.e., response was faster for congruent trials ( $M = 527$  ms) than for incongruent trials ( $M = 533$  ms). However, analyses revealed a significant congruency by perceived injustice interaction ( $F(1,51) = 5.22$ ,  $\epsilon = .77$ ;  $\text{Ndf}(.59, 39.27)$   $p <.05$ ) indicating that selective attention to pain faces was dependent upon participants' level of perceived injustice. No other significant main or interaction effects were observed (all  $F < 2.44$ , ns).

To interpret this significant interaction, two univariate ANCOVAs were performed with mean attentional bias (AB) index (i.e., across LFE, MFE, HFE trials) as the dependent variable and high (1 SD above the mean) or low values (1SD below the mean) of perceived injustice as the covariate. As shown in Figure 1, findings revealed significant selective attention to pain faces ( $M_{AB} = 13.22$ ;  $F(1,52) = 9.32$ ,  $p < .01$ ) among participants who reported high levels of perceived injustice, indicating greater tendency to shift attention towards pain faces among these participants. No significant effect was observed for participants who reported low levels of perceived injustice ( $M_{AB} = -.83$ ;  $F(1,58) = .04$ , ns).

Following additional correlational analyses indicating that higher AB to pain (mean AB index) was significantly associated with both pain and perceived difficulty following task



performance (both  $r = .29, p < .05$ ; a prerequisite for mediation) we further investigated the mediating role of participants' AB to pain in the relationship between perceived injustice and participant pain and difficulty appraisals, respectively.

#### The mediating role of attention bias to pain

Bootstrapping mediation analysis with pain intensity ratings as the outcome variable, perceived injustice as independent variable and AB as proposed mediator supported that perceived injustice was positively and significantly associated with pain intensity ratings following task performance ( $c = .07, SE = .02, p < .01$ ) and AB to pain ( $a = .53, SE = .24, p < .05$ ). With respect to the effect of the mediator, analyses showed that AB to pain was no longer significantly associated with pain intensity ratings ( $b = .02, SE = .01, ns$ ). No evidence for mediation was found. Indeed, the indirect effect ( $ab = .01, SE = .01$ , i.e., simple mediation) was found to be non-significant as the bias corrected (BC) bootstrapped confidence interval (95% BC CI:  $-.003$  to  $.05$  with 5000 resamples) included zero. Bootstrap analyses with difficulty appraisals following task performance revealed similar findings ( $c = .07, SE = .02, p < .01$ ;  $a = .53, SE = .24, p < .05$ ;  $b = .02, SE = .01, ns$ ;  $ab = .01, SE = .01$ ; 95% BC CI:  $-.01$  to  $.04$ , indicating that perceived injustice was positively and significantly associated with AB and difficulty ratings, yet the relationship between perceived injustice and difficulty ratings was not mediated by AB to pain.

#### Picture ratings

Picture ratings were examined using repeated measures ANOVAs. Means and standard deviations of rated pain intensity, anger and sadness for each level of facial pain expressiveness are shown in Table 2. Analyses with *pain intensity* as the dependent variable indicated significant differences between varying levels of facial pain expressiveness ( $F(3.49)=295.80$ ,

$p < .0001$ ). Differences between ratings were in the expected direction (see Table 2). Specifically, contrasts revealed that high expressive pain faces were rated significantly higher in terms of pain intensity than moderately expressive pain faces, moderately expressive pain faces were rated significantly higher than low expressive pain faces, and low expressive pain faces were rated significantly higher than neutral faces. No main or interaction effects were observed for participants' level of perceived injustice (both  $F < 1.34$ , ns).

Repeated measures ANOVAs with *anger* and *sadness* ratings, respectively, indicated significant differences between varying levels of facial expressiveness, with greater pain expressiveness perceived as indicative of greater levels of anger ( $F(3.49)=57.20$ ,  $p < .0001$ ) and sadness ( $F(3.49)=33.64$ ,  $p < .0001$ ; see Table 2). No interaction effects were observed with participants' level of perceived injustice (both  $F < .44$ , ns). However, in contrast to pain intensity analyses (which showed no relationship with perceived injustice), *participants' level of perceived injustice was significantly associated with both anger ratings* ( $F(1.51)=6.32$ ,  $p < .05$ ) *and sadness ratings* ( $F(1.51)=13.04$ ,  $p < .0001$ ), indicating that higher levels of perceived injustice were associated with greater perception of anger and sadness in faces characterized as relevant for future personal pain experience.

## DISCUSSION

The present study investigated the relationship between perceived injustice and attentional bias (AB) toward pain in a sample of individuals with chronic low back pain asked to perform a series of common everyday activities. We hypothesized that (1) perceived injustice would be positively associated with AB to pain, (2) both perceived injustice and AB would be associated with greater self-reported pain and perceived difficulty in response to task

performance, and (3) that AB would mediate the relationship between participants' perception of pain-related injustice and both pain intensity and difficulty appraisals. Results partially supported our hypotheses and can be summarized as follows. First, as expected, results indicated that perceived injustice was associated with greater AB to pain and higher ratings of pain experience and perceived difficulty following physical task performance. AB was likewise positively associated with pain and difficulty appraisals. However, counter to expectations, we found no support for the mediating role of AB to pain. As a final aim, exploratory analysis yielded interesting findings regarding the association between injustice perception and participants' appraisal of pictorial pain stimuli (i.e., faces presented during the dot probe task); specifically, participants who endorsed higher levels of perceived injustice rated faces as sadder and angrier.

Our findings contribute to the literature in several ways. To our knowledge, the current study represents the first investigation of the relationship between injustice perception and AB to pain. Accordingly, our findings extend the growing body of research regarding known correlates of perceived injustice. Given the previously demonstrated associations between perceived injustice and variables associated with pain and disability (including pain catastrophizing and pain-related fear [26,38,39,41]), this finding is perhaps not surprising, as these constructs/cognitions also show association with AB (e.g., [1,18,45,56]). Although this was not directly assessed in the current study, it is important to note that previous research acknowledges some overlap between perceived injustice and pain catastrophizing [38]; however, perceived injustice has been conceptualized (and supported) as a distinct construct reflecting elements of blame and anger, which are not captured by pain catastrophizing [29,38,55]. Further, the association between anger and perceived injustice may be reflected in our exploratory findings of pictorial stimuli.

As noted, AB to pain has been proposed as a possible mechanism by which perceived injustice exerts its negative impact on physical and psychological outcomes across a number of pain conditions [31,38]. However, findings indicated that AB did not mediate this relationship. A likely explanation for this finding is that perceived injustice represents a stronger predictor of pain and difficulty appraisals than does AB. However, the absence of a mediating role for AB could also be due to its operationalization. Indeed, reaction time tasks (i.e., based upon the registration of manual response latencies) are often found to be less reliable and more prone to noise [6,46]. Furthermore, the dot-probe paradigm employed in the current study assessed AB for pain at one particular moment in time (500ms). AB assessed at earlier or later stages in time, may have shown a stronger relationship with pain and difficulty appraisals (e.g., [21]) However, this explanation is tentative; future research using other methodologies to assess AB is warranted. Tracking participants eye movement while viewing another's pain expression might be particularly relevant as this would provide a more direct and continuous index of attentional processing, hence allowing to more precisely study the temporal dynamics of observer's attentional biases [52]. Second, it is possible that AB – while a relevant contributor – may not solely explain the association between perceived injustice and negative outcomes. Given the association between perceived injustice and pictorial ratings of sadness and anger (discussed below) a possible explanation for this non-significant finding may be that attention to cues of anger and sadness – rather than or in addition to pain per se - may be more salient. Indeed, a recent eye-tracking study [24] found that fear of pain (previously found to be associated with perceived injustice; [38,41]) tended to increase attentional preference to faces displaying anger. However, the role of AB to specific affect is of course speculative and must be examined in further research. Last, it is also possible that the strength of relationship between AB and pain is

dependent upon the context in which AB is assessed. This reasoning is in line with previous research showing that AB, and its effects, is dependent upon the context in which it is assessed [28]. AB may then be found to be only a mediator in the context of high anger or sadness. Yet, again, further research is necessary to address this explanation.

To date, previous studies have largely assessed the association between perceived injustice and general reports of pain and disability (e.g., [31,38,41, but see [5]). The current study is the first to examine the association between perceived injustice and in-vivo appraisals of pain and difficulty in response to common physical tasks (or in a sample composed exclusively of individuals with chronic low back pain). As noted, these tasks were modeled after an established paradigm [8-10] and purposefully chosen to extend the ecological validity of existing studies. Accordingly, the demonstrated association between perceived injustice and appraisals of common everyday activity represents an extension of existing literature, suggesting that elevated perceptions of injustice may have an everyday -- and potentially reinforcing -- impact upon pain and disability of individuals with chronic pain. Such daily/continual reinforcement may, in turn, contribute to the reported difficulty of altering injustice perceptions via standard multidisciplinary rehabilitation programs [38]. Incorporating forgiveness interventions or ACT-based strategies have been suggested as potentially relevant in this regard [22].

In the same vein, very few studies have examined the impact of attention to pain upon everyday life tasks of those with chronic pain (e.g., [27,48]). Indeed, research on AB to pain has mainly focused on its role in healthy participants and experimental pain tasks (e.g., the cold-pressor paradigm [42,49]). In this way, the current findings corroborate demonstrated associations between AB to pain and reported pain and disability among individuals with chronic pain [4,33,48]. Collectively, such findings suggest that AB toward pain may contribute to greater

pain/difficulty appraisals of everyday physical activity, and may ultimately contribute to greater disability. Accordingly, these findings further attest to the critical role of modifying attention to pain within clinical interventions or its underlying cognitions that fuel AB for pain [34,47].

To our knowledge this is also the first study to identify an association between perceived injustice and ratings of pictorial pain stimuli. Although exploratory, positive associations between injustice perception and ratings of sadness and anger (as perceived in faces) reflect existing literature. For example, given the strong association between injustice perception and catastrophizing, the findings are in line with interpretive biases demonstrated by high catastrophizers as seeing others in more pain [14,40,51]. However, in contrast to these studies, no association was observed between perceived injustice and pain intensity ratings; the effect was confined to ratings of anger and sadness. With respect to ratings of sadness, the association between perceived injustice and depression is well documented [26,30,31,38,39,41]. Further, a recent study by Scott and colleagues pointed to the association of perceived injustice with various indices of anger [31]. More importantly, Scott et al. found that anger mediated the relationship between perceived injustice and reported pain and depression suggesting that anger perceptions may play a particularly important role in injustice outcomes [31].

As noted, these observed associations are difficult to interpret; the faces presented were primed to be personally relevant, thus it is possible that participants' ratings of anger and sadness reflected their own affect. Conversely, it is possible that higher injustice perceptions may contribute to greater interpretation of anger and sadness in the social environment; this may in turn stress social interactions/relationships that can already be challenging for individuals with chronic pain [2,3,19]. Again, such speculation must be tested empirically.

## **Limitations**

Several limitations of the current study must be noted and potentially inform future research. First, the pictures used in the dot-probe are of people who posed pain expressions which may slightly differ from genuine expressions of pain [16]. Although this may have affected our findings, pain ratings indicated that faces were perceived as neutral, in low pain, moderate pain, and high pain as intended. Second, given the associations between perceived injustice and affect ratings, it is possible that our results may have inadvertently tapped into participants' attention to sadness and anger. As noted, this can be examined using experimental paradigms (such as eye-tracking) specifically utilizing such stimuli. Third, although the current study examined appraisal of everyday physical activity, assessment of pain and difficulty may have been limited; future studies should consider examining additional dimensions such as pain behavior or persistence in a pain-generating activity. Finally, the lab-based nature of the current findings limit their generalizability; more ecologically-valid longitudinal designs are needed (e.g., momentary assessment, e.g., [48]).

Despite the above limitations, the current study contributes to the limited literature on the interface between perceived injustice, AB to pain, and in-vivo appraisals of physical activity. Further, our findings offer preliminary data regarding potential interpretative bias among individuals with higher injustice perceptions and suggest that this is a fruitful line of research that may be examined across a number of pain populations.

## References

- [1] Asmundson GJG, Carleton RN, Ekong J. Dot-probe evaluation of selective attentional processing of pain cues in patients with chronic headaches. *Pain* 114:250–256, 2005.
- [2] Cano A. Pain catastrophizing and social support in married individuals with chronic pain: the moderating role of pain duration. *Pain* 110:656–664, 2004.
- [3] Cano A, Leong L, Heller JB, Lutz JR. Perceived entitlement to pain-related support and pain catastrophizing: associations with perceived and observed support. *Pain* 147:249–254, 2009.
- [4] Chapman S, Martin M. Attention to pain words in irritable bowel syndrome: increased orienting and speeded engagement. *Br J Health Psychol* 16:47–60, 2011.
- [5] Crombez G, Van Ryckeghem DM, Eccleston C, Van Damme S. Attentional bias to pain-related information: a meta-analysis. *Pain* 154:497–510, 2013.
- [6] Dear BF, Sharpe L, Nicholas M, Refshauge K. The psychometric properties of the dot-probe paradigm when used in pain-related attentional bias research. *J Pain* 12:1247–1254, 2011.
- [7] De Clercq A, Crombez G, Buysse A, Roeyers H. A simple and sensitive method to measure timing accuracy. *Behav Res Methods Instrum Comput* 35:109–115, 2003.
- [8] De Ruddere L, Goubert L, Prkachin KM, Stevens MA, Van Ryckeghem DM, Crombez G. When you dislike patients, pain is taken less seriously. *Pain* 152:2342–2347, 2011.
- [9] De Ruddere L, Goubert L, Stevens MAL, Deveugele M, Craig KD, Crombez G. Health care professionals' reactions to patient pain: impact of knowledge about medical evidence and psychosocial influences. *J Pain* 15:262–270, 2014.



- [10] De Ruddere L, Goubert L, Vervoort T, Kappesser J, Crombez G. Impact of being primed with social deception upon observer responses to others' pain. *Pain* 154:221–226, 2013.
- [11] Eccleston C, Crombez G. Pain demands attention: a cognitive-affective model of the interruptive function of pain. *Psychol Bull* 125:356–366, 1999.
- [12] FACS Manual. Paul Ekman Group, LLC n.d. Available: <http://www.paulekman.com/product/facs-manual/>. Accessed 18 Feb 2016.
- [13] Ferrari R, Russell AS. Perceived injustice in fibromyalgia and rheumatoid arthritis. *Clin. Rheumatol.* 33:1501–1507, 2014.
- [14] Goubert L, Vervoort T, Cano A, Crombez G. Catastrophizing about their children's pain is related to higher parent-child congruency in pain ratings: an experimental investigation. *Eur J Pain* 13:196–201, 2009.
- [15] Hayes AF. Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs* 76:408–420, 2009.
- [16] Hill ML, Craig KD. Detecting deception in pain expressions: the structure of genuine and deceptive facial displays. *Pain* 98:135–144, 2002.
- [17] Holmbeck GN. Post-hoc probing of significant moderational and mediational effects in studies of pediatric populations. *J Ped Psychol* 27:87–96, 2002.
- [18] Keogh E, Cochrane M. Anxiety sensitivity, cognitive biases, and the experience of pain. *J Pain* 3:320–329, 2002.
- [19] Kool MB, van de Schoot R, López-Chicheri García I, Mewes R, Da Silva JAP, Vangronsveld K, Wismeijer AAJ, Lumley MA, van Middendorp H, Bijlsma JWJ, Crombez G, Rief W, Geenen R. Measurement invariance of the Illness Invalidiation

- Inventory (3\*I) across language, rheumatic disease and gender. *Ann Rheum Dis* 73:551–556, 2014.
- [20] Koster EHW, Crombez G, Verschuere B, De Houwer J. Selective attention to threat in the dot probe paradigm: differentiating vigilance and difficulty to disengage. *Behav Res Ther* 42:1183–1192, 2004.
- [21] Liossi C, White P, Schoth DE. Time-course of attentional bias for threatrelated cues in patients with chronic daily headache-tension type: evidence for the role of anger. *Eur J Pain* 15:92–98, 2011.
- [22] Monden KM, Trost Z, Scott W, Bogart KR, Driver S. The Unfairness of It All: Exploring the Role of Injustice Appraisals in Rehabilitation Outcome. *Rehab psychol* 61:44-53, 2016.
- [23] Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav Res Methods Instrum Comput* 36:717–731, 2004.
- [24] Priebe JA, Messingschlager M, Lautenbacher S. Gaze behaviour when monitoring pain faces: An eye-tracking study. *Eur J Pain* 19:817–825, 2015.
- [25] Prkachin KM, Schultz I, Berkowitz J, Hughes E, Hunt D. Assessing pain behaviour of low-back pain patients in real time: concurrent validity and examiner sensitivity. *Behav Res Ther* 40:595–607, 2002.
- [26] Rodero B, Luciano JV, Montero-Marin J, Casanueva B, Palacin JC, Gili M, del Hoyo YL, Serrano-Blanco A, Garcia-Campayo J. Perceived injustice in fibromyalgia: Psychometric characteristics of the Injustice Experience Questionnaire and relationship with pain catastrophising and pain acceptance. *Journal of Psychosomatic Research* 73:86–91, 2012.

- [27] Roelofs J, Peters ML, Patijn J, Schouten EG, Vlaeyen JW. Electronic diary assessment of pain-related fear, attention to pain, and pain intensity in chronic low back pain patients. *Pain* 112:335–342, 2004.
- [28] Schrooten MG, Van Damme S, Crombez G, Peters ML, Vogt J, Vlaeyen JW. Nonpain goal pursuit inhibits attentional bias to pain. *Pain* 153:1180-1186, 2012.
- [29] Scott W, Sullivan M. Perceived injustice moderates the relationship between pain and depression. Abstract published in The Journal of Pain’s annual meeting supplemental issue 12:81, 2011.
- [30] Scott W, Sullivan M. Perceived injustice moderates the relationship between pain and depressive symptoms among individuals with persistent musculoskeletal pain. *Pain Res Manage* 17:335–340, 2012.
- [31] Scott W, Trost Z, Bernier E, Sullivan MJ. Anger differentially mediates the relationship between perceived injustice and chronic pain outcomes. *Pain* 154:1691–1698, 2013.
- [32] Scott W, Trost Z, Milioto M, Sullivan MJ. Further validation of a measure of injury-related injustice perceptions to identify risk for occupational disability: a prospective study of individuals with whiplash injury. *J Occup Rehabil* 23:557–565, 2013.
- [33] Sharpe L, Haggman S, Nicholas M, Dear BF, Refshauge K. Avoidance of affective pain stimuli predicts chronicity in patients with acute low back pain. *Pain* 155:45–52, 2014.
- [34] Sharpe L, Ianiello M, Dear BF, Nicholson Perry K, Refshauge K, Nicholas MK. Is there a potential role for attention bias modification in pain patients? Results of 2 randomised, controlled trials. *Pain* 153:722-731, 2012.
- [35] Simon D, Craig KD, Gosselin F, Belin P, Rainville P. Recognition and discrimination of prototypical dynamic expressions of pain and emotions. *Pain* 135:55–64, 2008.

- [36] Sullivan MJ, Adams H, Martel MO, Scott W, Wideman T. Catastrophizing and perceived injustice: risk factors for the transition to chronicity after whiplash injury. *Spine* 36:S244-4, 2011.
- [37] Sullivan MJ, Scott W, Trost Z. Perceived injustice: a risk factor for problematic pain outcomes. *Clin J Pain* 28:484–488, 2012.
- [38] Sullivan MJL, Adams H, Horan S, Maher D, Boland D, Gross R. The role of perceived injustice in the experience of chronic pain and disability: Scale development and validation. *J Occup Rehabil* 18:249–261, 2008.
- [39] Sullivan MJL, Davidson N, Garfinkel B, Siriapaipant N, Scott W. Perceived injustice is associated with heightened pain behavior and disability in individuals with whiplash injuries. *Psychol Inj Law* 2:238–247, 2009.
- [40] Sullivan MJL, Martel MO, Tripp DA, Savard A, Crombez G. Catastrophic thinking and heightened perception of pain in others. *Pain* 123:37–44, 2006.
- [41] Sullivan MJL, Thibault P, Simmonds MJ, Milioto M, Cantin AP, Velly AM. Pain, perceived injustice and the persistence of post-traumatic stress symptoms during the course of rehabilitation for whiplash injuries. *Pain* 145:325–331, 2009.
- [42] Todd J, Sharpe L, Johnson A, Nicholson Perry K, Colagiuri B, Dear BF. Towards a new model of attentional biases in the development, maintenance, and management of pain. *Pain* 156:1589–1600, 2015.
- [43] Trost Z, Agtarap S, Scott W, Driver S, Guck A, Roden-Foreman K, Reynolds M, Foreman ML, Warren AM. Perceived injustice after traumatic injury: Associations with pain, psychological distress, and quality of life outcomes 12 months after injury. *Rehabil Psychol* 60:213–221, 2015.

- [44] Trost Z, Vangronsveld K, Linton SJ, Quartana PJ, Sullivan MJ. Cognitive dimensions of anger in chronic pain. *Pain* 153:515–517, 2012.
- [45] Van Damme S, Crombez G, Eccleston C. Disengagement from pain: the role of catastrophic thinking about pain. *Pain* 107:70–76, 2004.
- [46] Van Damme S, Crombez G, Notebaert L. Attentional bias to threat: a perceptual accuracy approach. *Emotion* 8:820–827, 2008.
- [47] Van Ryckeghem D, Crombez G. Attentional bias and chronic pain: where to go from here? *Pain* 155: 6-7, 2014.
- [48] Van Ryckeghem DML, Crombez G, Goubert L, De Houwer J, Onraedt T, Van Damme S. The predictive value of attentional bias towards pain-related information in chronic pain patients: a diary study. *Pain* 154:468–475, 2013.
- [49] Van Ryckeghem DML, Crombez G, Van Hulle L, Van Damme S. Attentional bias towards pain-related information diminishes the efficacy of distraction. *Pain* 153:2345–2351, 2012.
- [50] Vervoort T, Caes L, Crombez G, Koster E, Van Damme S, Dewitte M, Goubert L. Parental catastrophizing about children's pain and selective attention to varying levels of facial expression of pain in children: a dot-probe study. *Pain* 152:1751–1757, 2011.
- [51] Vervoort T, Caes L, Trost Z, Notebaert L, Goubert L. Parental attention to their child's pain is modulated by threat-value of pain. *Health Psychol* 31:623–631, 2012.
- [52] Vervoort T, Trost Z, Prkachin KM, Mueller SC. Attentional processing of other's facial display of pain: an eye tracking study. *Pain* 154:836–844, 2013.

- [53] Vervoort T, Trost Z, Van Ryckeghem DML. Children's selective attention to pain and avoidance behaviour: the role of child and parental catastrophizing about pain. *Pain* 154:1979–1988, 2013.
- [54] Vlaeyen JW, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain* 85:317–332, 2000.
- [55] Yakobov E, Scott W, Stanish W, Dunbar M, Richardson G, Sullivan M. The role of perceived injustice in the prediction of pain and function after total knee arthroplasty: *Pain* 155:2040–2046, 2014.
- [56] Yang Z, Jackson T, Gao X, Chen H. Identifying selective visual attention biases related to fear of pain by tracking eye movements within a dot-probe paradigm. *Pain* 153:1742–1748, 2012.

### **Figure Legends**

*Figure 1.* Mean attentional bias index as a function of low (1SD below the mean) and high (1SD above the mean) levels of perceived injustice;  $*p < .05$

Table 1.

*Bivariate Correlations*

Variable	M(SD)	Range	1	2	3	4
1. Age (years)	39.13 (13.16)	19 – 70				
2. Duration of pain (years)	9.18 (6.90)	1 – 30	.27*			
3. Perceived Injustice (IEQ)	21.91 (13.08)	2 – 47	.32*	.28*		
4. Pain Intensity NRS	2.39 (2.30)	0 – 8.75	.11	.23	.41**	
5. Perceived Difficulty NRS	2.18 (2.16)	0 – 7.65	.16	.22	.41**	.98**

\* $p < .05$ , \*\* $p < .01$ ; IEQ = Injustice Experiences Questionnaire; Pain Intensity/Perceived Difficulty NRS = Average pain ratings/perceived difficulty ratings collected using a Numerical Rating Scale.



Table 2.

*Picture ratings for pain, anger and sadness for each level of facial pain expressiveness*

	NFE <i>M (SD)</i>	LFE <i>M (SD)</i>	MFE <i>M (SD)</i>	HFE <i>M (SD)</i>	<i>F</i> -test
Pain ratings	.83 (1.22)	3.57 (1.5)	5.3 (1.49)	7.39 1.62)	295.80***
Anger ratings	1.35 (1.75)	3.09 (1.75)	4.00 (2.18)	4.70 (2.18)	57.20***
Sadness ratings	2.49 (2.25)	3.68 (1.88)	4.19 (1.66)	5.08 (1.94)	33.64***

\*\*\*  $p < .0005$ ; \*\*  $p < .005$ ; \*  $p < .01$ ; Different indices indicate significant differences between groups. NFE: neutral facial expression of pain; LFE: low facial expression of pain; MFE: moderate facial expression of pain; HFE: high facial expression of pain

*Table 3.*

*Mean reaction times (in milliseconds) and standard deviations (SD) on congruent and incongruent trials for low, moderate, and high facial pain expression*

	Congruent trials	Incongruent trials
Low facial pain expression	526 (115)	535 (123)
Moderate facial pain expression	522 (117)	528 (115)
High facial pain expression	531 (119)	534 (118)

# Perceived Injustice and Attentional Bias 35

